First and Final Report to the National Aeronautics and Space Administration of:

CYCLE-DEPENDENT STUDIES OF SEMI-REGULAR GIANT STARS

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CYCLE-DEPENDENT STUDIES OF SEMI-REGULAR GIANT STARS

Philip G. Judge, P.I. (University of Colorado)

This NASA grant covers my IUE observing program involving the acquisition and analysis of chromospheric data of three semi-regular giant stars strategically placed in the HR diagram to study mass-loss and chromospheric heating processes. The work is mostly complete and I am proceeding to write up the results for presentation at the summer 1991 AAS meeting and for publication in the *Astronomical Journal.*

Results to date

Our results can be best summarised in the form of the figures and Tables which are attached to this report.

To summarize, these figures show very significant ($> 3\sigma$) and substantial variability of the profiles of Mg II resonance lines. The detailed changes in the line profiles reveal several clues to the mechanisms leading to chromospheric heating and mass-loss: (i) the changes are not always symmetric with respect to the red and blue wings of the lines. This implies that substantial spatial inhomogeneities are present on a geometrical scale comparable to the stellar sizes. (ii) The most dramatic changes occur near the self-reversed line "cores" where the profiles are formed high in the chromospheric layers. (iii) In g Her statisically significant changes occur only in the *red* wings of the k. This supports the previously suggested hypothesis that this part of the line is obliterated by overlying absorption by circumstellar material.

Table 2
LOG OF IUE OBSERVATIONS.

Star/Image	Disp.	Exp. time	FES counts[a] (Target)	FES counts (Comparison)	Date[b]	notes
g Her						
LWP 15845	HI	40m	441	724	185	
LWP 15846	LO	4m			185	
LWP 15939	HI	55m	436	745	197	
LWP 16015	HI	55m	437	741	210	
LWP 16102	HI	55m	442	749	224	
LWP 16170	HI	70m	443	753	231	
LWP 16269	HI	55m	467	732	245	
LWP 16312	HI	70m	455	...	252	
LWP 16365	LO	5m	449	731	258	
LWP 16366	LO	10m			258	
LWP 16367	LO	5m			258	
LWP 16411	LO	5m	449	...	266	
LWP 16458	LO	5m	457	...	273	
ρ Per						
LWP 16069	HI	13m	1113	265	217	
LWP 16104	HI	15m	1159	...	224	
LWP 16171	HI	15m	1190	...	231	
LWP 16213	HI	12m	1182	...	238	
LWP 16214	LO	45s			238	
LWP 16270	HI	12m	1145	269	245	
LWP 16214	LO	50s	1212	266	252	
LWP 16311	HI	10m			252	
LWP 16364	HI	11m	1234	257	258	
LWP 16410	HI	12m	1174		266	
LWP 16456	HI	12m	1158	24406[c]	273	
R Lyr						
LWP 15847	HI	20m	763		185	
LWP 15940	HI	20m	710	13032[c]	197	
LWP 16016	LO	2m	698	12679[c]	210	
LWP 16017	HI	20m			210	
LWP 16070	HI	20m	736	11906[c]	217	
LWP 16071	LO	2m			217	
LWP 16103	HI	20m	789	...	224	
LWP 16212	HI	20m	813	12530[c]	238	
LWP 16409	HI	20m	628	12736[c]	266	
LWP 16457	LO	2m	696	...	273	

NOTES: *a* FES counts in the fast track underlap mode. *b* Date = Julian Date -2,447,526.5. *c* FES counts in the fast track overlap mode.

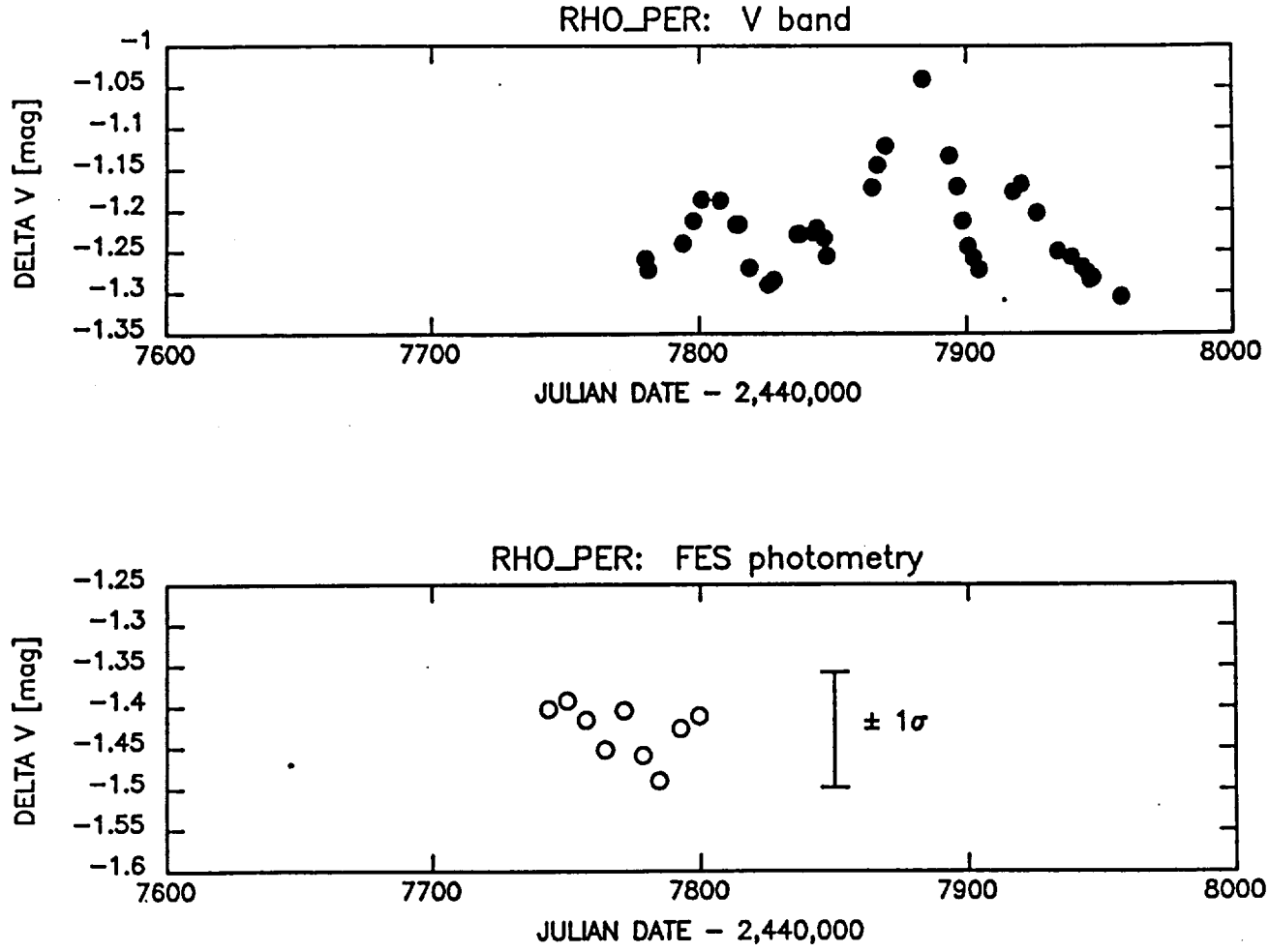

Figure 1: Ground-based photometry and IUE FES photometry for the three target stars. The V-magnitudes are given as $V(target)$ - $V(comparison)$ from both the Phoenix-10 telescope and from the FES photometry computed as described by Fireman and Imhoff (1989). Both datasets for each star are normalized to the same comparison stars. The offsets ($\sim$ 0.2 and $\sim$ 0.7 magnitudes for ρ Per and g Her respectively) result from the poor calibration of the FES photometry for very red stars.

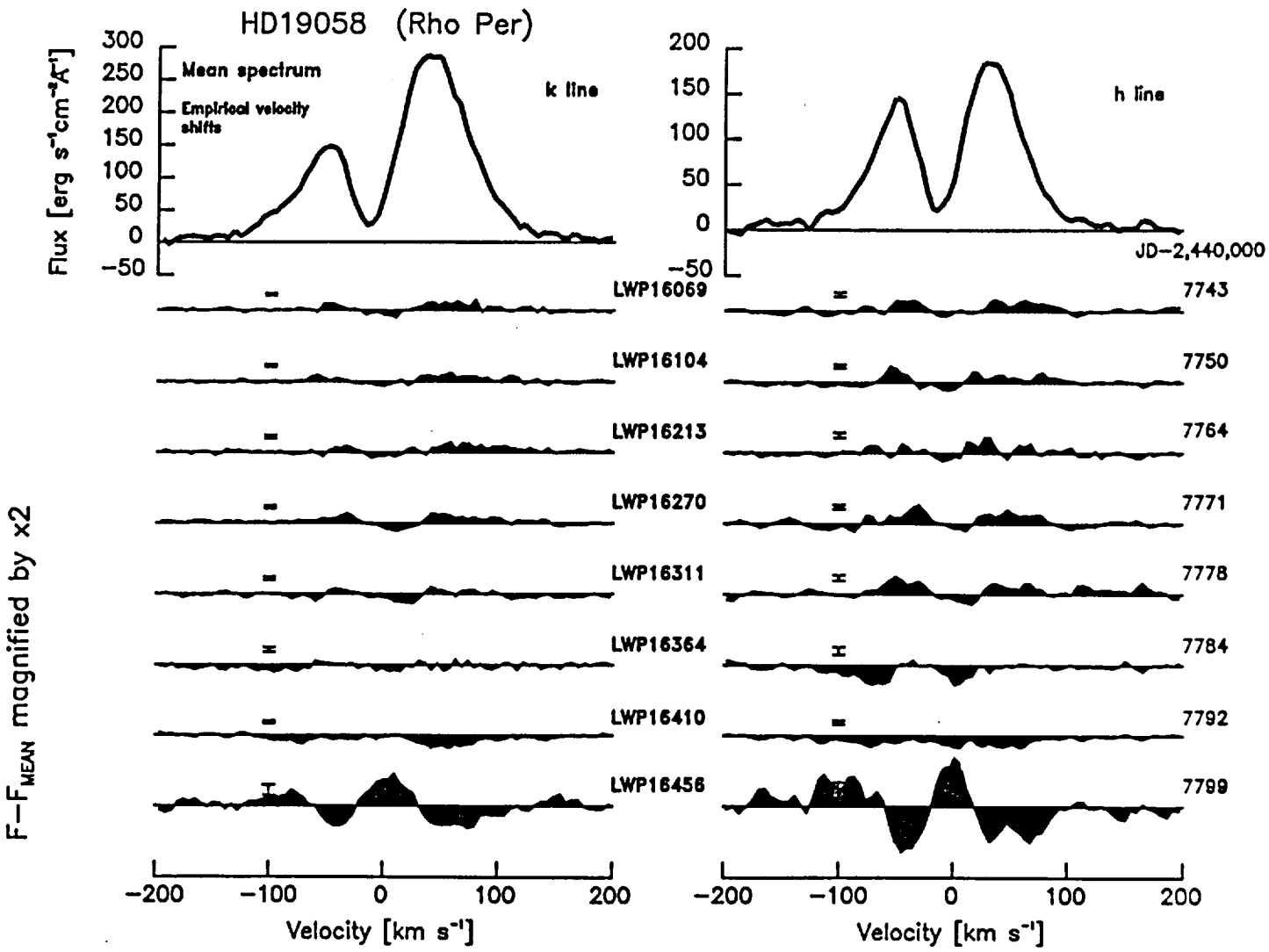

Figure 2: Spectra of the Mg II h and k lines obtained in the time-series observations of ρ Per. The top panel shows the "mean" spectrum obtained by an unweighted average of the individual spectra. The abscissa is the Doppler shift in km s^{-1}. (Note that for optically thick lines such as Mg II h and k these velocities do not represent directly the actual gas motions, but instead depend on the radiation transport). The lower panels show the difference between the individual spectra and the mean spectrum, with fluxes magnified by a factor of 2 for clarity. The $\pm 1\sigma$ error bars were computed from the standard deviations of the fluxes between the (absolute) Doppler shift velocities of 150 and 250 km s^{-1}.

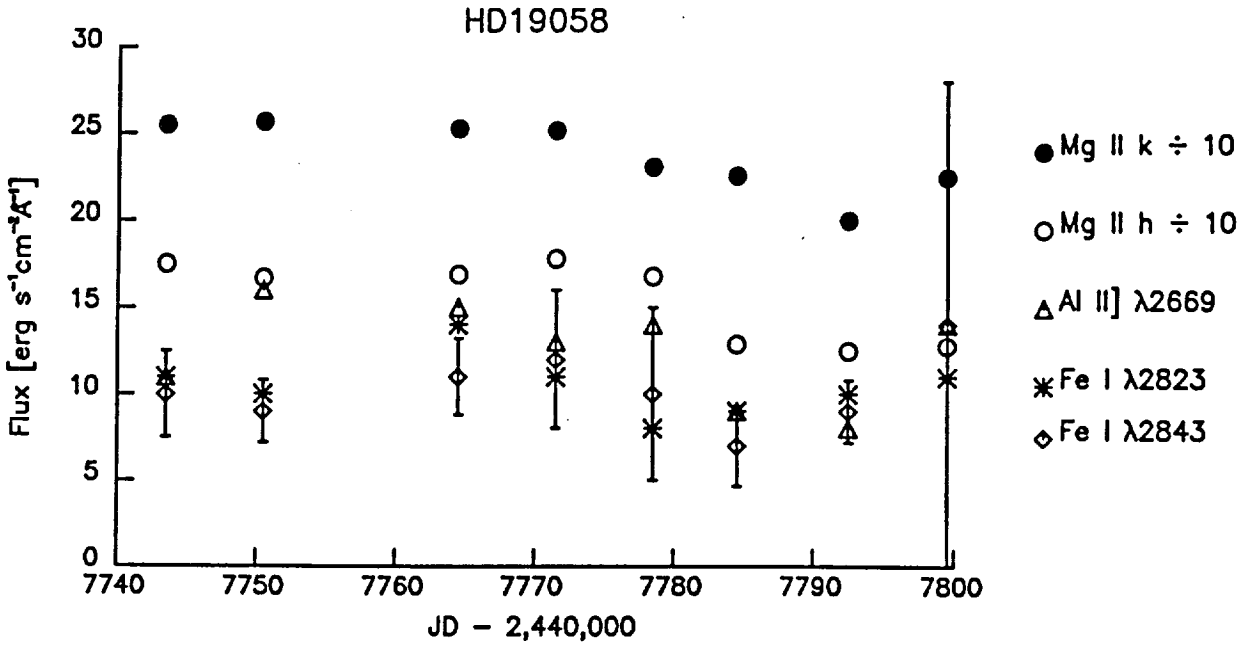

Figure 3: Variations in the integrated fluxes of the Mg II, Fe I and Al II] lines in the time series spectra of ρ Per. Contrary to the findings of Eaton et al (1990), we find no evidence for statistically significant differences between the behavior of the various emission lines in any of our stars.